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Design, Construction, and Maintenance of Subsurface Drains in Arid and Semiarid Areas

Exhibit 50
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Bodle 2-16-12
Patterson Reporting & Video

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ASABE, 2950 Niles Road, St. Joseph, MI 49085-9659, USA ph. 269-429-0300, fax 269-429-3852, hq@asabe.org

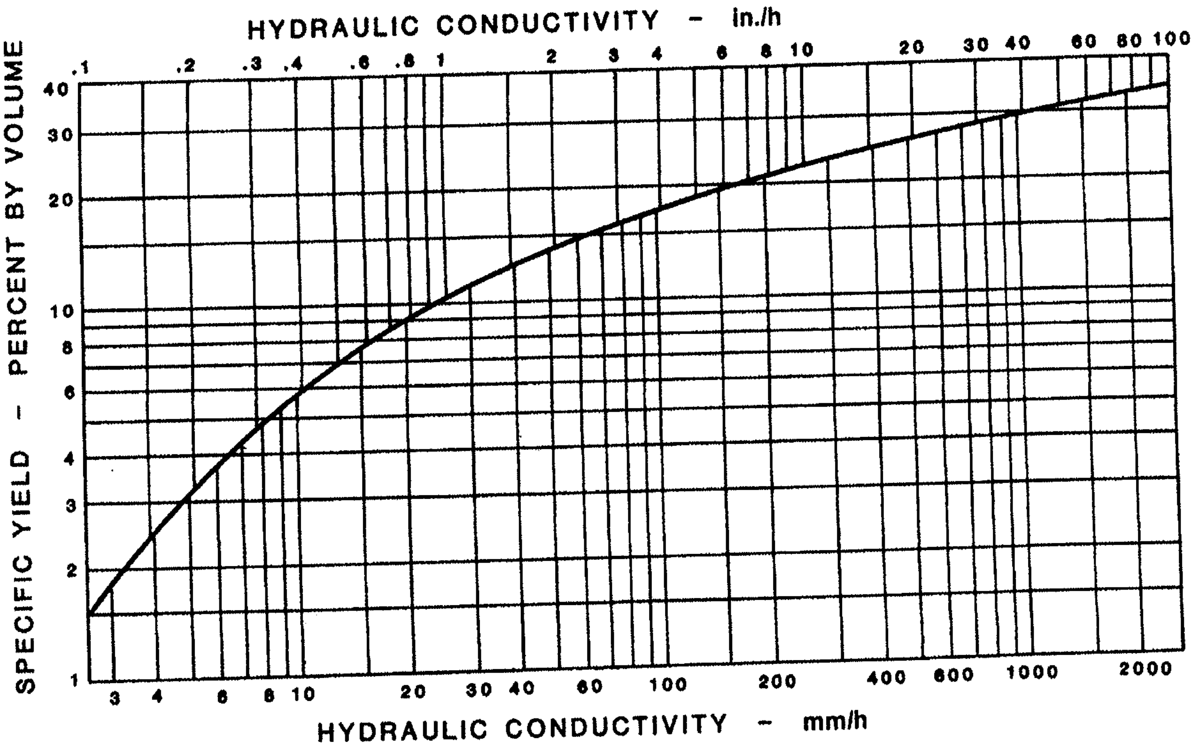

Figure 1 – Curve showing general relationship between specific yield and hydraulic conductivity

a depth by the shortest time interval between deep percolation events, usually the time between irrigations at the peak of the season.

5.3.7 Drain spacing equations. Numerous methods for calculating drain spacing exist, but the Donnan steady-state equation and the US Bureau of Reclamation transient flow method are in common use.

5.3.7.1 Steady-state method. Donnan's steady-state equation can be expressed as:

$$L^2=\frac{4K(b^2-a^2)}{Q_d}$$

where

- L is drain spacing, m (ft);
- K is hydraulic conductivity, m/day (ft/day);
- a is distance from drain depth to barrier layer, m (ft);
- b is distance from maximum allowable water table height to the barrier layer;
- Q_d is recharge rate, m/day (ft/day) (see 5.3.6).

When the drain is to be placed on or near the barrier layer, it has been found through field experience by the US Bureau of Reclamation that drain spacing can be calculated by the following equation:

$$L^2=\frac{8Kb^2}{Q_d}$$

Example:
Steady-state with drain above the barrier layer:

- L is drain spacing, m (ft);
- K is 3.05 m/day (10 ft/day);
- a is 6.71 m (22 ft);
- b is 7.92 m (26 ft);

deep percolation/irrigation is 25.4 mm (1 in.);
time between irrigations at peak of season is 14 days.

$$Q_d=\frac{25.4\ \text{mm}}{14\ \text{days}\ (1000\ \text{mm/m})}=0.00181\ \text{m/day}$$

$$L_2=\frac{4(3.05)(7.92^2-6.71^2)}{14\ \text{days}\ (1000\ \text{mm/m})}$$

$$L=345\ \text{m}$$

$$Q_d=\frac{1\ \text{in.}}{14\ \text{days}\ (12\ \text{in./ft})}=0.00595\ \text{ft/day}$$

$$L_2=\frac{4(10)(26^2-22^2)}{0.00595}$$

$$L=1{,}136\ \text{ft}$$

5.3.7.2 Transient flow method. The US Bureau of Reclamation's transient flow method for determining drain spacing takes into account the transient nature of ground-water recharge and discharge. This method simulates actual fluctuations of the water table to drain spacings that meet the requirement of keeping the water table below a specified depth. Figure 2 shows the dimensionless parameters Y/Y_0 vs. KDt/SL^2 and Z/H vs. KHt/SL^2 based on the transient flow theory. This figure shows the relationship for the water height at the midpoint between drains for cases in which drains are located above a barrier layer or on a barrier layer. Figure 2 can be used to find the proper drain spacing for dynamic equilibrium of the water table. However, water table elevations should be computed for an entire year to account for water removal by the drains during non-irrigated periods. Table 2 shows an example of